

Federal Technology Deployment Pilot: Exterior Solid State Lighting

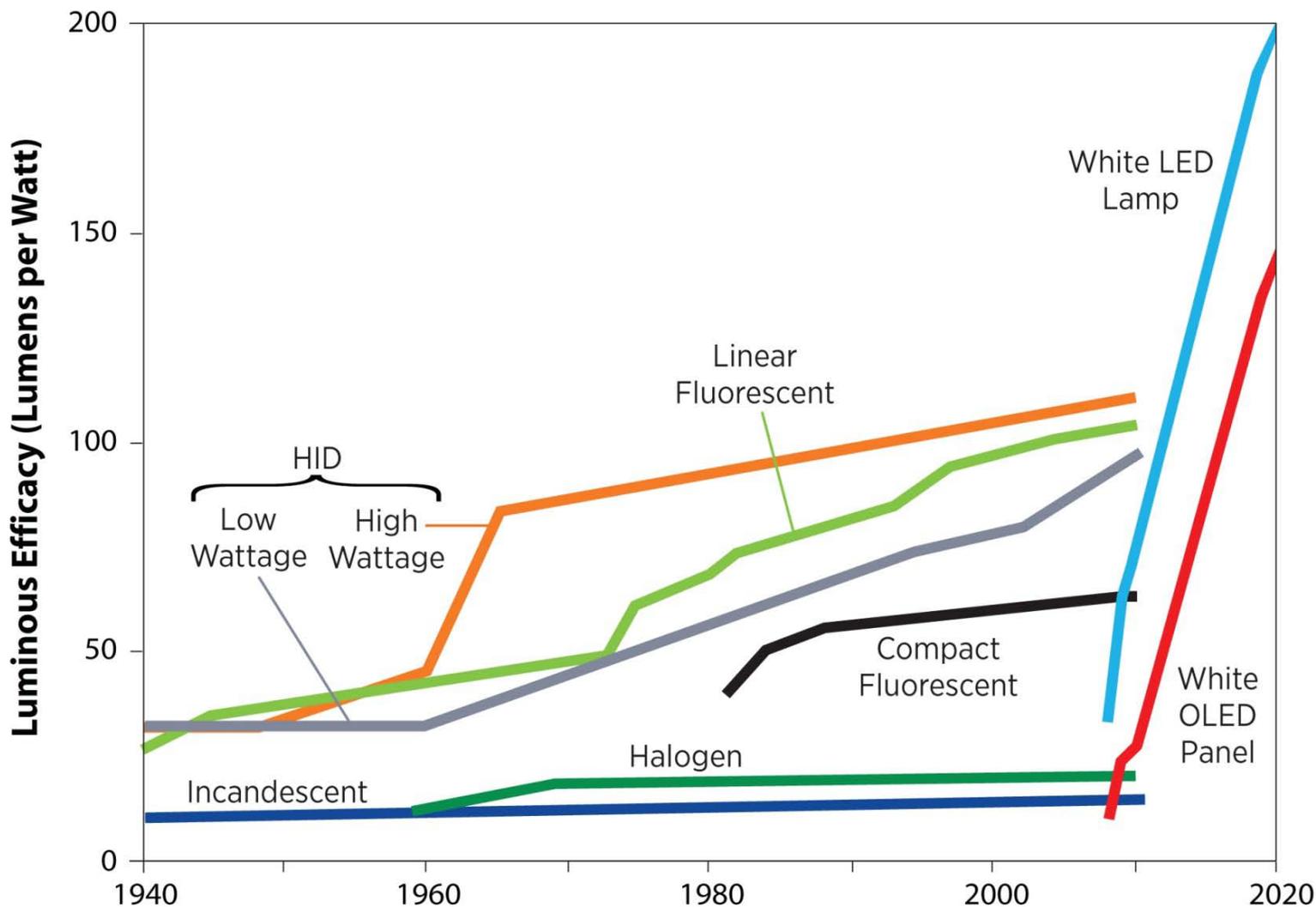
October 24, 2011

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Pacific Northwest National Laboratory
Richland, Washington

- Overview of DOE's Solid-State Lighting Program
- Federal Technology Deployment Pilot: Exterior Solid State Lighting
- FEMP Technology Deployment Matrix

Energy Savings Potential of Solid-State Lighting

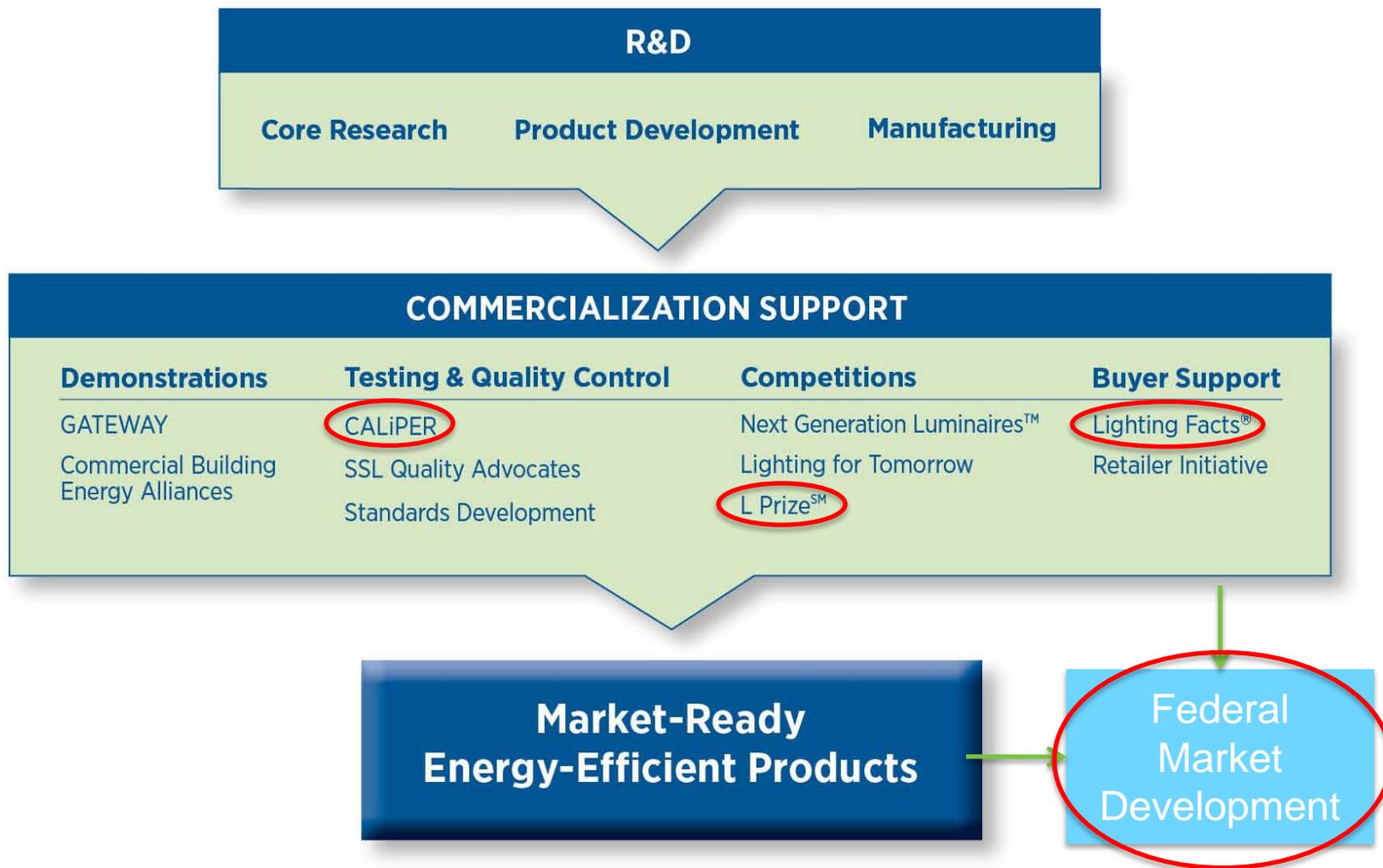


SSL Multi-Year Program Plan, May 2011: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2011_web.pdf

- Value
 - Superior photometrics, CRI
 - Long life
 - Efficiency upside
 - Controllability; instant on, dimming
- Challenges
 - Credibility of manufacturer claims
 - LED color consistency, Lamp to lamp, and over time
 - Reliability: LED device plus optics, thermal management, and other components
 - Dimming, flicker, glare
 - Product cost, availability

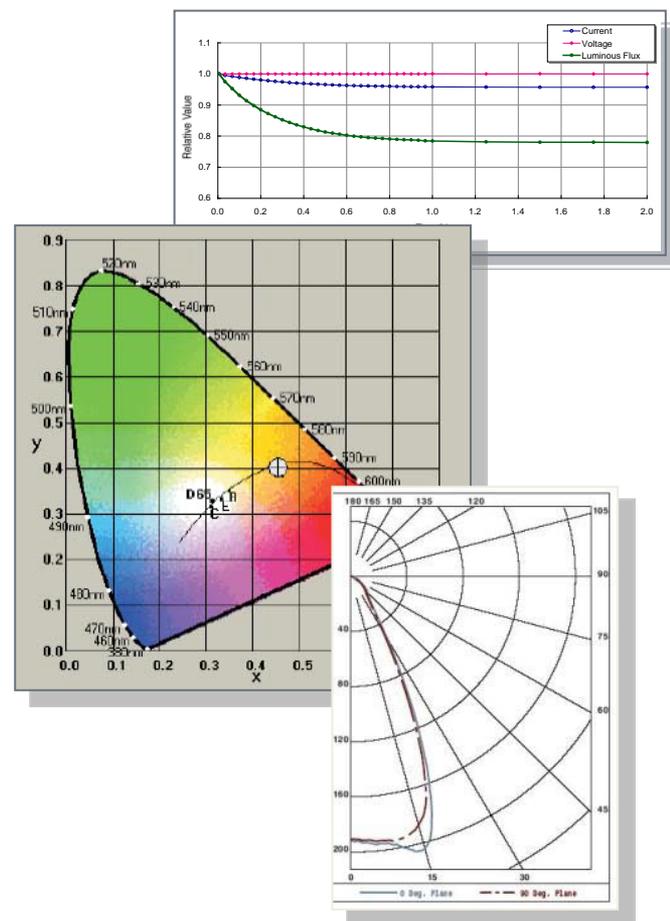


Source: Acuity Brands Lighting



- **DOE Sponsored Research** – For high CRI SSL luminaires, efficacy is expected to go from a typical level of 65 lm/W today to 150 lm/W in 2020 and to 180 lm/W in 2030. **Demonstrates “upside” potential** for SSL roadway, exterior area and parking structure LED lighting applications.
- **CALiPER Testing Program** – Provides check on performance claims and **builds confidence in products** for Federal energy managers and procurement officials.
- **Lighting Standards and Test Procedures Development** – 7 key documents completed to date, including Photometric Measurement (IES LM-79) and Lumen Depreciation (IES LM-80). **Enables apples to apples comparison of competing technologies** by Federal decision makers.
- **SSL GATEWAY Demonstrations** – Showcase SSL products in real applications, including outdoor lighting, providing valuable data on performance, energy savings, and payback. **Validates costs and performance in real world applications, increasing confidence by Federal decision makers.**
- **Commercial Building Energy Alliances** – CBEA-led Specifications completed for Parking Lot and Parking Structure Lighting; **basis for Federal policies.**
- **State and Municipal SSL Street Lighting Consortium** – Cities, power providers, and others who invest in street lighting share experiences, best practices, lessons learned from LED street lighting demonstrations; **platform/model for Federal market collaboration.**

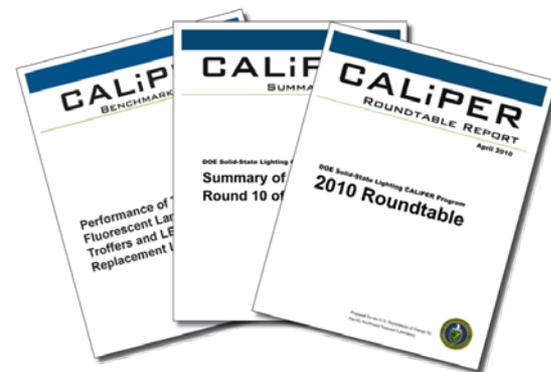
- Supports independent testing of wide array of SSL, benchmark, and demo products
 - Guides DOE planning
 - Informs development of standards and test procedures
- Rounds 1–12 completed
 - Includes roadway, linear replacement lamps, high-bay luminaires, small replacement lamps
- Reports available online



CALiPER Reports and Analysis

Identify Technology Issues, Trends

- Summary reports provide detailed analysis of results for all products tested in each round
- Detailed test reports provide results for each product tested; available through searchable, sortable database
- Benchmark reports compare LED products with conventional lighting technologies
- Exploratory studies provide nuanced analysis of test results related to critical issues (e.g., reliability, color shift)



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Solid-State Lighting

HOME ABOUT THE PROGRAM RAD PROJECTS MARKET-BASED PROGRAMS SSL BASICS INFORMATION RESOURCES FINANCIAL OPPORTUNITIES

EEER > Building Technologies Program > Solid State Lighting > Market Based Programs > CALiPER Program

Category Search

Search using any or all data fields, for a comparative listing of information from CALiPER detailed reports. Multiple selections are allowed within round number and category fields.

Category: All Cove Downlight Outdoor Area Post Top Round #: 10
Test Date From: 7/28/2006 To: 6/13/2011
CCT Range From: To:
Sort By: Search

Search Results

Below are 302 results of your search. The following documents are available as Adobe Acrobat PDFs: [Download Adobe Reader.](#)

You search results below were based on your search for:
Category: All
Round: All
Test Date: From 7/28/2006 To 6/13/2011

Thumbnail	Light	Category	Round	Test	CALiPER	Power	Initial	Initial	CCT (K)	CRI	Power	Report
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- CALiPER: Independent lab testing of commercially available LED and benchmark products
 - Over 350 products tested; reports available
- GATEWAY: Demonstrations of LED products in real applications
 - Lessons learned; reports available

LOOKING GOOD	NOT COMPETITIVE YET
<ul style="list-style-type: none">• Recessed downlights• Outdoor, parking garage, wall pack luminaires• Refrigerator case lighting	<ul style="list-style-type: none">• 4' linear replacement lamps• Small replacement lamps• Cove lighting (when replacing linear fluorescents)
<div style="border: 1px solid black; padding: 5px; display: inline-block;">Troffers</div>	

CALiPER data, www.ssl.energy.gov/caliper.html; GATEWAY data, www.ssl.energy.gov/gatewaydemos.html

- www.lightingfacts.org

Brand Brand X

Light Output/Lumens
Measures light output. The higher the number, the more light is emitted.
Reported as "Total Integrated Flux (Lumens)" on LM-79 test report.

Watts
Measures energy required to light the product. The lower the wattage, the less energy used.
Reported as "Input Power (Watts)" on LM-79 report.

Lumens per Watt/Efficacy
Measures efficiency. The higher the number, the more efficient the product.
Reported as "Efficacy" on LM-79 report.

Color Rendering Index (CRI)
Measures color accuracy.
Color rendition is the effect of the lamp's light spectrum on the color appearance of objects.

Correlated Color Temperature (CCT)
Measures light color.
"Cool" colors have higher Kelvin temperatures (3600–5500 K); "warm" colors have lower color temperatures (2700–3500 K). Color temperatures higher than 6500 are outside of the defined region for white light, but may be appropriate for outdoor applications.

IESNA LM-79-2008
Industry standardized test procedure that measures performance qualities of LED luminaires and integral lamps. It allows for a true comparison of luminaires regardless of the light source.

Registration Number
Model Number
Type

Visit www.lightingfacts.com for the Label Reference Guide.

Registration Number: ABC435TH4782023
Model Number: 18756CH756428954FRGHT1234HJ
Type: 18756CH756428954FRGHT1234HJ

All results are according to IESNA LM-79-2008: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.

- Created by Energy Independence and Security Act (EISA 2007) Sec. 655
- Focus on two replacement technologies:
 - 60 W Incandescent
 - PAR 38 Halogen
- Future focus: 21st Century Lamp
- Cash prizes, opportunities for federal purchasing agreements, utility programs, other incentives
- Opportunity to save significant energy and greenhouse gas emissions

- Exceptional efficacy
- Long life
- Form factor identical to lamps they replace
- Additional details specified for
 - Quality
 - Performance
 - Mass manufacturing

Competition Requirements

60W Incandescent Replacement Lamp

- *More than 90 lm/W*
- *Less than 10 watts*
- *More than 900 lumens*
- *More than 25,000 hour life*
- *More than 90 CRI*
- *Between 2700-3000 K CCT*

PAR 38 Halogen Replacement Lamp

- *More than 123 lm/W*
- *Less than 11 watts*
- *More than 1,350 lumens*
- *More than 25,000 hour life*
- *More than 90 CRI*
- *Between 2700-3000 K CCT*

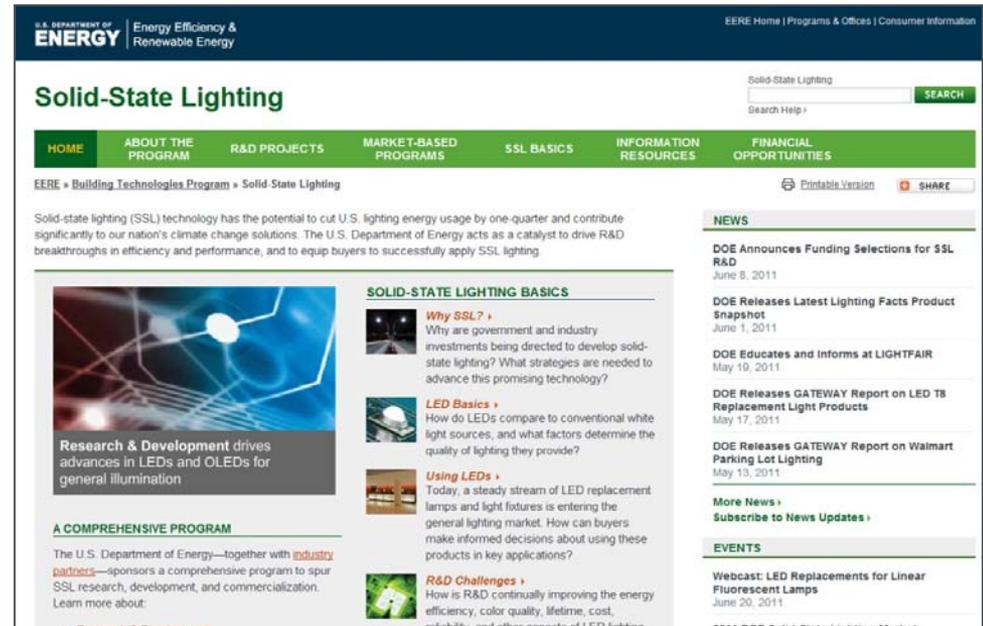
21st Century Lamp

- *To be defined in a future L Prize Program Announcement*

- First entry received from Philips in September 2009
 - Rigorous evaluation under way
 - Photometric testing completed
 - Long-term testing completed
 - Stress testing completed
 - Field testing completed (1,300 products, 14 partners, 40 sites)
 - Technical Review Committee evaluation under way
- **Update: Aug. 2011 “Philips Lighting Wins the L-Prize”**



- Current information on SSL program, progress, and events
- SSL publications
 - Roadmaps
 - Reports
 - Technical fact sheets
- Solicitations
- Register for ongoing SSL Updates



www.ssl.energy.gov
www.ssl.energy.gov/gatewaydemos.html
www.ssl.energy.gov/consortium.html
www.ssl.energy.gov/caliper.html

Goal - To develop and demonstrate a process by which an emerging, underutilized, commercially proven technology can be placed in a default position for acquisition purposes.

Why SSL exterior lighting?

- Huge energy savings potential in exterior SSL.
- Exterior applications are ripe for near term implementation through a thoughtful process that recognizes the technology's potential, as well as it's challenges.
- Leverages successful BTP and FEMP efforts.

What's needed from Stakeholders like you?

- Help identify unique Federal Sector needs, and provide guidance on tools and materials to support those needs.

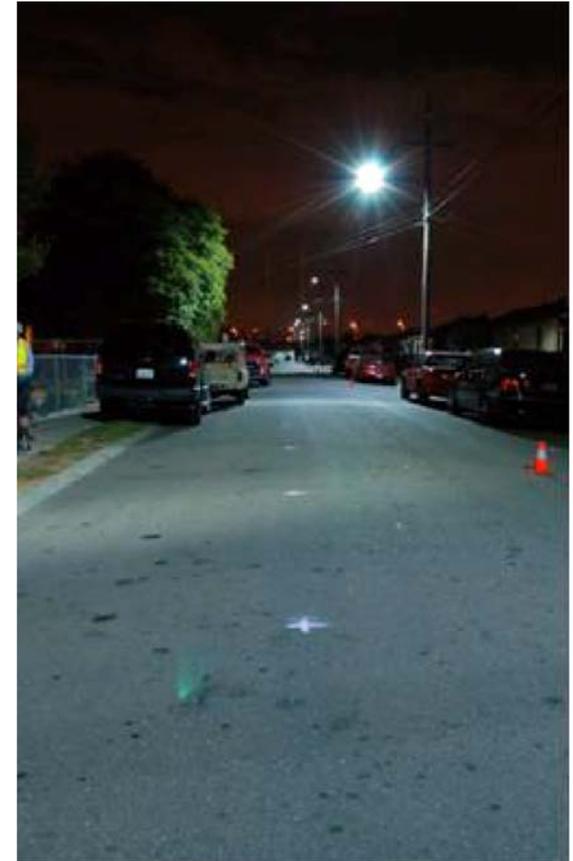


LED RoadStar luminaire with Dynadimmer dimming technology
NGL Recognized Winner 2010

Source: Phillips Roadway Lighting

Unique Federal Sector Challenges

- Market size is large, but unknown, requires study
- Multiple independent lighting policies
 - Navy, Army, Air Force, GSA all have their own criteria.
 - some have embraced SSL, but not in a consistent manner
- Inconsistent implementation of exterior lighting policies at regional/local level
- Acquisition system not well linked to technology advances and assessments
 - newer technology faces risk aversion, inertia
 - first cost v. best value tension an issue



City of Oakland, CA replaced fourteen 121 Watt HPS luminaires (100 nominal Watts) with fourteen 78 Watt LED luminaires (60 nominal Watts)

Source: PNNL

- Reports available online:
www.ssl.energy.gov/gatewaydemos_results.html



LED T8 Replacement Products: Seattle, WA (May 2011)



LED Roadway Lighting: Palo Alto, CA (June 2010)



LED Street Lighting: San Francisco, CA (Dec. 2008)



LED Parking Lot Lighting: Leavenworth, KS (May 2011)



LED Street Lighting: Portland, OR (Nov. 2009)



LED Parking Garage Lighting: Portland, OR (Nov. 2008)



LED Retrofit Lamps: San Francisco, CA (Nov. 2010)



LED Freezer Case Lighting: Eugene, OR (Oct. 2009)



LED Residential Downlights and Undercabinet Lights: Eugene, OR (Oct. 2008)



LED Museum Accent Lighting: Chicago, IL (Nov. 2010)



LED Roadway Bridge Lighting: Minneapolis, MN (Aug. 2009)



LED Walkway Lighting: Atlantic City, NJ (March 2008)



LED Parking Lot Lighting: Manchester, NH (June 2010)



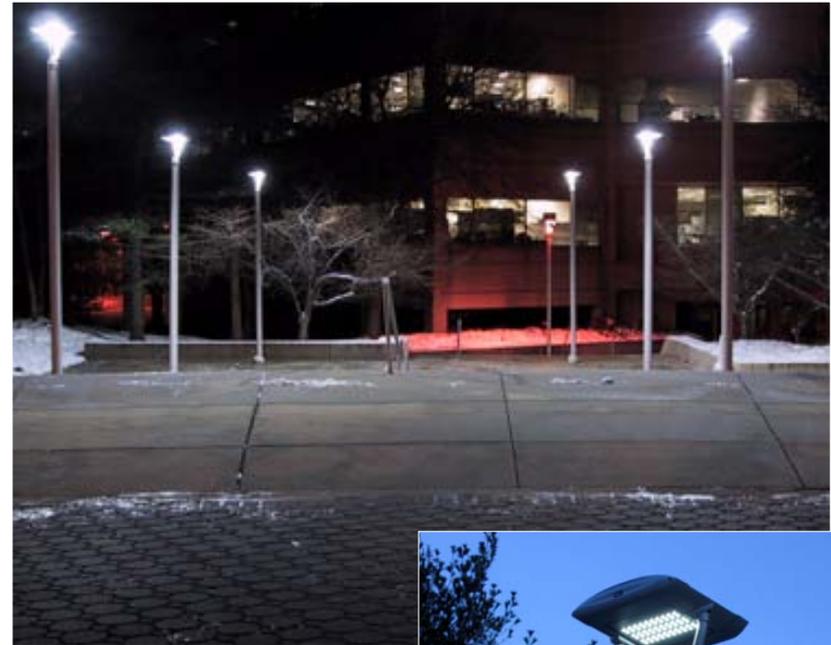
LED Parking Lot Lighting: West Sacramento, CA (Feb. 2009)



LED Street Lighting: Oakland, CA (Phase III, November 2008; Phase II, January 2008)

Federal Aviation Administration (FAA) William J. Hughes Technical Center in Atlantic City, NJ

- 6 LED luminaire replacements on 14-foot poles along exterior walkways
- Energy savings of up to 50%
- Lighting quality visibly improved
- Estimated 7-year payback for new construction (or replacing existing fixtures at their end of life)



New LED Luminaires



Close-up of 3-Bar LED

Source: PNNL

US Department of Labor Building, Washington, DC



Before (HPS)



After (LED & motion)



Close-up of Philips Wide-Lite VizorLED

- Integral occupancy sensor dims fixture to 10% power
- Initial minimum horizontal illuminance increased 21%; average decreased 53%
- 55% installed wattage reduction in high state; 95% reduction in low
- ~80% kWh energy savings expected, includes dimming
- 1:1 replacement
- ~8 year simple payback (for retrofit), ~5 year for new

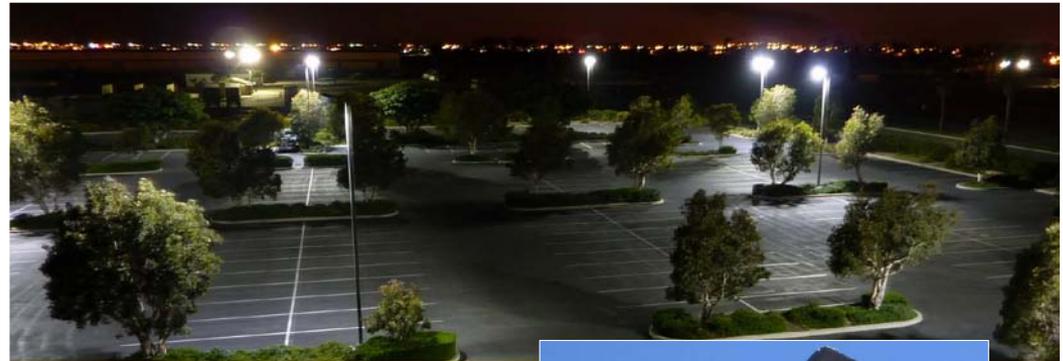


LED lighting installed in the parking garage of the Frances Perkins Building, U.S. Department of Labor headquarters, Washington, D.C.

Source: PNNL

NAVFAC Engineering Service Center at Port Hueneme, CA

- Light levels increased by 18% in dimly lit areas
- Lighting power was reduced 74% to 2.81 kW from 10.88 kW
- Illumination distribution more uniform
- Higher CCT; 6500K for LED compared to 2000K for HPS
- Instant on – no strike or re-strike delay
- Longer lamp life; an expected 50,000 hours for the LEDs and driver versus 24,000 hours average for HPS



New LED parking area lights at the NAVFAC Engineering Service Center at Port Hueneme provide high quality, evenly distributed light.



Close up view of new LED luminaires atop an existing light pole.

Source: PNNL



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Technical Requirements Table v1.6

SOLID STATE LIGHTING

[See a list of our category definitions here](#)

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Designlights™ Consortium Qualified Products List- Non-Residential Applications – Submit any or all of the following product information and testing results to Designlights for qualification *please make note that it is ONE per submission*							
PDF Download							
Application	Minimum Light Output	Zonal Lumen Density ²	Minimum Luminaire Efficacy	Allowable CCTs (ANSI C78.377-2008)	Minimum CRI	L70 Lumen Maintenance	Minimum Luminaire Warranty
1) Outdoor Pole/Arm-Mounted Area and Roadway Luminaires	1,000 lm	=100% 0-90°, <10% 80-90°	60 lm/W	≤5700K	50	50,000 hrs	5 years
2) Outdoor Pole/Arm-Mounted Decorative Luminaires	1,000 lm	≥65%: 0-90°	40 lm/W	≤5700K	50	50,000 hrs	5 years
3) Outdoor Wall-Mounted Area Luminaires	300 lm	=100% 0-90°, <10% 80-90°	60 lm/W	≤5700K	50	50,000 hrs	5 years
4) Bollards	500 lm	<15%: 90-110° 0%: >110°	35 lm/W	≤6500K	50	50,000 hrs	5 years
5) Wall-wash Luminaires	575 lm	≥50%: 20-40°	40 lm/W	2700K, 3000K, 3500K, 4000K, 4500K, 5000K	50	50,000 hrs	5 years
6) Parking Garage Luminaires	2,000 lm	≥30% 60-80°, ≤25% 70-80°	60 lm/W	≤5700K	50	50,000 hrs	5 years
7) Fuel Pump Canopy	2,000 lm	≥40%: 0° to 40°; ≥40%: 40° to 70°	70 lm/W	≤5700K	50	50,000 hrs	5 years

FEMPs Exterior SSL Technology Deployment

With support from FEMP, the USACE is developing a policy and implementation plan, including guidance materials, training, qualified product lists, and performance specifications in support of the widespread adoption of exterior SSL in the Federal sector.



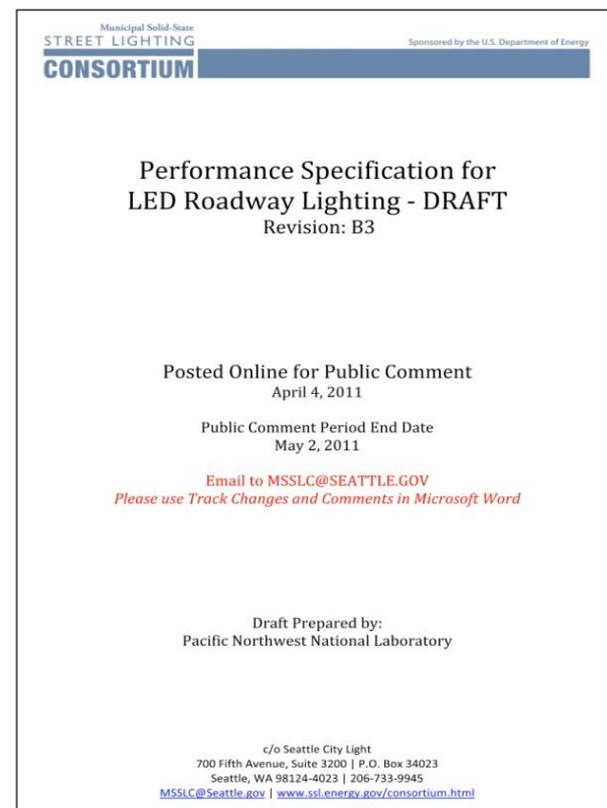
- Share experiences, best practices, lessons learned from LED street lighting demonstrations
- Regional workshops: Provide forum for education, collaboration on specifications and tools
- Demonstrations: Kansas City, MO; Sacramento, CA; Philadelphia, PA; Seattle, WA
- Resources: Draft Model Specification for LED Roadway Lighting; task group on Remote Monitoring & Adaptive Lighting Controls



Photo credit: Ryan Pyle

Municipal Solid-State
STREET LIGHTING
CONSORTIUM

- For use by municipalities, utilities, ESCOs as template to be edited by each user
- Provides a common language, framework, and checklist
- Appendix A provides consolidated criteria for each luminaire type, evaluating at site/system or luminaire/material level
- Final spec. released... yesterday!
- www.ssl.energy.gov/specification.html



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

FEDERAL ENERGY MANAGEMENT PROGRAM

A FEMP Outdoor SSL Initiative

Resources for Outdoor SSL Applications



LED lighting installed in the parking garage of the Frances Perkins Building, U.S. Department of Labor Headquarters, Washington, D.C.

Outdoor Solid-State Lighting in the Federal Sector

The Federal Energy Management Program (FEMP) is encouraging Federal agencies to accelerate the thoughtful application of outdoor solid state lighting luminaires. The FEMP Outdoor SSL Initiative offers a unique opportunity for the Federal sector to lead a large-scale implementation effort focused on an SSL application that is ripe for near term implementation through a process that recognizes the technology's potential, as well as its challenges. This initiative is intended to help Federal energy managers overcome the widespread misinformation they are encountering, learn about this technology and its unique attributes, and provide the tools needed to make good decisions that result in cost effective energy savings, and good quality lighting.

As part of this initiative, FEMP will leverage existing SSL outdoor tools and materials, and will develop new ones as needed to meet the unique needs of Federal agencies. This paper provides an overview of existing outdoor SSL resources developed by the US Department of Energy's SSL Program and other Federal initiatives including:

- SSL Street/Roadway Lighting
- SSL Site (Parking Lot/Garage) Lighting
- General SSL Resources

Street/Roadway Lighting

A variety of resources are available for facility managers interested in pursuing SSL street and roadway lighting, including DOE SSL GATEWAY demonstration project results, a Fitted Target Efficacy Calculator, and DOE CALiPER test results.

Municipal Solid-State Street Lighting Consortium Fact Sheet – The Consortium shares technical information and experiences related to LED street and area lighting demonstrations. The Consortium also serves as an objective resource for evaluating new products on the market intended for street and area lighting applications.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/consortium_fs.pdf

DOE SSL GATEWAY Demonstration Project Results – DOE GATEWAY demonstrations showcase high-performance LED products for general illumination in a variety of commercial and residential applications. Demonstration results provide real-world experience and data on state-of-the-art solid-state lighting (SSL) product performance and cost effectiveness. The following studies have been completed on Street/Roadway lighting:

- **LED Roadway Lighting: Palo Alto, California**
Assessment of energy, economic, and performance impacts of replacing high-pressure sodium street lights with LED and induction street lights.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_palo_alto.pdf

According to the U.S. Department of energy, no other lighting technology offers as much potential to save energy and enhance the quality of our building environments, contributing to our nation's energy and climate change solutions.

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/dec2010_guiding-market_factsheet.pdf

- **LED Street Lighting: Lija Loop, Portland, OR**
Analysis of the energy and performance impacts of replacing eight high-pressure sodium street lights on one residential street with LED luminaires.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_lija_loop.pdf
- **LED Roadway Lighting: I-35W Bridge**
Analysis of Phase 1 results, completed in September 2008, Phase 2 involves long-term monitoring to evaluate lumen depreciation, physical effects, and performance impacts over time.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_i-35w-bridge.pdf

[continued >](#)

Street/Roadway Lighting

- Municipal SSL Consortium
 - Performance Specification
- DOE SSL Gateway Demos
- CALiPER test Results

Parking Lot/Structure Lighting

- DOE SSL Gateway Demos
- CBEA Performance Specs
 - Lot and Structure Lighting

General Resources

- DOE SSL Program

Design Lights Consortium

- Qualifying Products Lists

- Technical Assistance to Exterior SSL policy Development
 - Provide technical guidance to the USACE (and others) on a policy to standardize with SSL technology in exterior areas. (expected in Nov.)
 - Construction Standard Specifications
- FEMP-Designated Exterior SSL Performance Levels and Product list
 - Utilize DesignLights Consortium Qualified Products List
- SSL Exterior Lighting outreach/education
 - Guides, training materials, field guides, fact sheets, etc.
- Exterior SSL Website link for Federal users:
 - http://www1.eere.energy.gov/femp/technologies/solid_state_lighting.html

- **Purpose:** Identify and rank new and underused technologies which hold the most promise to impact the federal market in order to prioritize resources
- Contains the top 50 ranked technologies.
- Located at:
http://www1.eere.energy.gov/femp/technologies/newtechnologies_workgroup.html

- **Federal Impact (50% Weighting)** – a combination of a technology’s energy savings potential and degree of applicability in the overall federal market.
- **Cost Effectiveness (30% Weighting)** – relative cost of the implementation and average expected return typically reported in case studies as simple payback period.
- **Probability of Success (20% Weighting)** – a combination of characteristics that are mostly qualitative.
 - Strength of Supply Chain
 - Knowledge Base
 - Implementation Difficulty
 - Customer Acceptance (referring to both the facility operator and occupants)

Technologies for Deployment - Top 20

Rank	Technology	Category	Weighted Score
1	Spectrally Enhanced Lighting	Lighting	91
2	Low Ambient / Task Lighting	Lighting	88
3	Condensing Boilers	HVAC	86
4	Super T8 Lighting	Lighting	79
5	Commercial Ground-source Heat Pumps	HVAC	66
6	High R-Value Windows	Building Envelope	65
7	Duct Sealants	HVAC	63
8	LED / Solid State Lighting - Interior	Lighting	61
9	LED / Solid State Lighting - Exterior	Lighting	59
10	PC Power Management	Other	58
11	Condensing Water Heaters - gas	Water Heating	58
12	Water Cooled Oil Free Magnetic Bearing Compressor	HVAC	54
13	Integrated Daylighting Systems	Lighting	53
14	Cool Roofs	Building Envelope	53
15	Bi-level Garage / Parking Lot / Pedestrian Lighting	Lighting	53
16	Wrap Around Heat Pipes	HVAC	53
17	Window Films	Building Envelope	53
18	Commercial Energy Recovery Ventilation Systems (ERV)	HVAC	52
19	Air-side Economizers and Filters for Data Centers	HVAC	52
20	Induction Lighting	Lighting	51

Technologies for Deployment – Second Tier

Rank	Technology	Category	Weighted Score
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Dry Climate Technologies

32	Multi-Stage Indirect Evaporative Cooling	HVAC	48
44	Evaporative Precooling Systems	HVAC	36

Humid Climate Technologies

34	Dehumidification Enhancements for A/C in hot-humid climates	HVAC	46
38	Liquid Desiccant Air Conditioner	HVAC	42

Hi-Bay Lighting Technologies

21	HID Electronic/Dimming Ballasts	Lighting	51
36	Efficient High Bay Fluorescent Lighting	Lighting	42
42	High Bay LED	Lighting	37

HVAC Control Retrofits

22	HVAC Occupancy Sensors	HVAC	51
27	CO2 Demand Ventilation Control (DVC)	HVAC	50
29	Demand Control Ventilation for Commercial Kitchen Hoods	HVAC	50
35	Compressor Cycling Controller	HVAC	45

Other Important Technologies

24	Data Center Cooling System Air Distribution Optimization	HVAC	51
37	Advanced Rooftop Packaged AC	HVAC	42
26	Bi Level Stairwell Lighting	Lighting	50

Technologies for Deployment (21-50)

Rank	Technology	Category	Weighted Score
21	HID Electronic/Dimming Ballasts	Lighting	51
22	HVAC Occupancy Sensors	HVAC	51
23	Vending Machine Occupancy Sensor	Other	51
24	Data Center Cooling System Air Distribution Optimization	HVAC	51
25	Tankless Water Heater - Gas	Water heating	50
26	Bi Level Stairwell Lighting	Lighting	50
27	CO ₂ Demand Ventilation Control (DVC)	HVAC	50
28	Thermal Displacement Ventilation	HVAC	50
29	Demand Control Ventilation for Commercial Kitchen Hoods	HVAC	50
30	Active Chilled Beam Cooling with Dedicated OSA Ventilation	HVAC	49
31	Heat Pump Water Heater	Water Heating	48
32	Multi-Stage Indirect Evaporative Cooling	HVAC	48
33	Colored Paint for heat reflective or absorptive applications	Building Envelope	47
34	Dehumidification Enhancements for A/C in hot-humid climates	HVAC	46
35	Compressor Cycling Controller	HVAC	45
36	Efficient High Bay Fluorescent Lighting	Lighting	42
37	Advanced Rooftop Packaged AC	HVAC	42
38	Liquid Desiccant Air Conditioner	HVAC	42
39	Solar Water Heating	Water Heating	41
40	Thermal Destratifiers	HVAC	40
41	Refrigeration Management System	Refrigeration	38
42	High Bay LED	Lighting	37
43	Off-peak Precooling	HVAC	37
44	Evaporative Precooling Systems	HVAC	36
45	Wireless Temperature Sensors	HVAC	34
46	Airfield LED Lighting	Lighting	34
47	Green Roofs	Building Envelope	33
48	Aerogel Insulation - Piping, Ducts, and Buildings	Building Envelope	28
49	Smart Windows	Building Envelope	25
50	Phase Change Insulation	Building Envelope	21

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